

13 January 1971

Materiel Test Procedure 9-4-003
Tropic Test Center

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON TROPIC ENVIRONMENTAL TEST PROCEDURE

CONSTRUCTION, SUPPORT AND SERVICE EQUIPMENT

AD 720562

1. OBJECTIVE

This document is a guide to test methods and techniques for determining the capability of construction, support and service equipment to function effectively within tropic environments.

2. BACKGROUND

Construction equipment can often operate effectively and efficiently in a temperate environment, but due to extreme humidity, heat, profusion of insects, vegetation, corrosion, etc., suffer reduced efficiency, structural degradation, or become inoperative in tropic environments. Testing, therefore, is required to determine if new equipment after having met stated performance criteria in temperate and/or simulated tropic environments will indeed function properly and maintain its operating efficiency when operated in wet-warm and wet-hot tropic environments. (See Appendix A in MTP 2-4-003 for a detailed description of typical environmental and meteorological conditions found in the tropics.)

3. REQUIRED EQUIPMENT

One or more of the following items and/or facilities may be required to obtain data during the various evaluations:

- a. Tape measure, (steel) 0 to 60.9 meters (200 feet).
- b. Photographic equipment (still and motion).
- c. Appropriate materials handling equipment (MHE).
- d. Platform-type weighing scales.
- e. Stopwatch.
- f. Item under test (test item).
- g. Suitable test sites and storage areas as defined in MTP 2-4-003.
- h. Recovery vehicle.
- i. Reference or comparison items as required.

4. REFERENCES

- A. AR 70-38, Research and Development: Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
- B. USAMC Regulation 385-12, Verification of Safety of Materiel from Development Through Testing and Supply Disposition.
- C. USAMC Regulation 385-224, Safety Manual.
- D. USAMC Pamphlet 702-3, Quality Assurance Reliability Handbook.
- E. USAMC Pamphlet 706-134, Engineering Design Handbook: Maintainability Guide for Design.

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- F. USATECOM Regulation 70-23, Research and Development of Materiel: Equipment Performance Reports (EPRs).
- G. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
- H. USATECOM Regulation 700-1, Quality Assurance: Value Engineering.
- I. USATECOM Regulation 750-15, Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- J. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE) Guidebook Supplement.
- K. MIL-STD-129, Marking for Shipment and Storage.
- L. MIL-STD-794, Parts and Equipment, Procedures for Packaging and Packing of.
- M. MIL-STD-1472, Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
- N. TM 743-200, Storage and Materials Handling.
- O. FM 31-30, Jungle Training and Operations.
- P. MTP 8-4-004, Long Term Surveillance/Environmental Testing of CBR Munitions, Weapons and Equipment.
- Q. MTP 9-3-500, Physical Characteristics.
- R. Specific Volume 9 MTP for item under evaluation.

5. SCOPE

This MTP is intended to be used as a guide in conjunction with the MTP for the specific commodity item(s) undergoing service tests. Reference is made to other MTP's for the actual test procedures to be followed in assessing the test item's physical condition, technical characteristics, and operating performance. The primary intention of this MTP is to specify the environmental conditions under which such testing is to be performed, collect data relating the item's performance to continued tropic exposure, and evaluate the data collected to determine the suitability of the test item for use in the tropics.

5.1 SUMMARY

This MTP describes the following tests to be performed in a tropical environment on construction, support and service equipment.

5.1.1 Preparation for Test

This section provides guidance for test project planning, a description of facilities and equipment required, instructions for test personnel training and familiarization, and a typical mission scenario.

5.1.2 Test Conduct

a. Initial Inspection and Operating Characteristics - A determination of the test item's condition upon arrival and an assessment of its

operating characteristics prior to conducting environmental testing. This data will be used as a base for comparison with corresponding data developed during subsequent testing.

b. Operational Performance - An evaluation to determine the capability of the test item to perform its intended mission.

c. Storage - An evaluation of the capability of the test item and/or components to be stored for short intervals in the tropics and not suffer loss of operability, efficiency, structural strength, or safety in operation.

d. Surveillance - An evaluation of the capability of the test item to withstand long term storage, while properly packed and packaged for storage in a tropic environment.

e. Security from Detection - An evaluation to determine the capability of the test item to avoid detection when stored or operated in a humid tropic environment.

f. Maintenance Evaluation - An evaluation to determine the maintenance characteristics and requirements of the test item.

g. Safety - An evaluation to determine the safety characteristics and possible hazards of test item operation.

h. Human Factors - An evaluation to determine those design and performance characteristics affecting the test item user.

i. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of cost reduction without compromising performance, reliability, quality, maintainability or safety.

5.1.3 Test Data

This section details the raw data to be collected and recorded while completing the test procedures in paragraph 6.2., Test Conduct.

5.1.4 Data Reduction

This section provides instructions for analyzing and evaluating the raw data and presenting the results.

5.2 LIMITATIONS

a. The material presented in this MTP is limited to field testing in the humid tropics. Guidance for testing equipment in simulated environments or other induced tropic conditions has been intentionally omitted.

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b. Procedures outlined in this MTP do not constitute detailed test plans. Tropic environment testing should be performed utilizing the guidance in this MTP, but each cognizant agency must determine the applicability of the procedures and how best to obtain the required data from the test item(s).

c. The diversity of construction, support and service equipment to which this MTP is applicable precludes detailed coverage of any particular item.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Test Project Planning

The test project officer and other designated personnel must:

a. Conduct a thorough study of stated requirements as contained in the QMR, SDR, TC and test directive to insure that complete and suitable test criteria are selected.

b. Review all instructional material issued with the test item by the manufacturer and reports of previous tests conducted on similar equipment.

c. Prepare a detailed test schedule showing proposed time periods allotted for each test. Insure that testing is scheduled in test courses with both cleared and uncleared terrain in wet-warm and wet-hot environments. These environments and test courses are defined in paragraph 3 and Appendix A of MTP 2-4-003. Testing should be scheduled in these areas during the peak of the wet season (October through November) and the dry season (January through March). Wherever applicable, testing should also be conducted in areas that introduce salt-air and salt-spray exposure to the test item(s).

d. Prepare record forms and test logs for systematic entry of data, chronology of test, and evaluation in the final analysis of the test item's suitability for use in the tropics.

e. Review the safety release. Tabulate the safety precautions that must be followed to insure safe operation of the test item(s), and include all applicable safety SOPs.

f. Plan the utilization of photographic techniques where necessary to record and document test results.

6.1.2 Test Personnel Training and Familiarization

a. Evaluate the adequacy of all technical manuals and safety instructions used by test personnel.

b. Instruct personnel as follows:

TABLE I

Personnel Instructions

Personnel	To be instructed in
All	<ul style="list-style-type: none">a. The purpose of the test.b. The characteristics of the test item.c. The characteristics of the reference item, if any.d. The kind of data to be obtained.e. The terrain(s) in which testing is to be conducted.f. The health precautions to be observed in the terrain(s) required for test conduct.
Test and reference item operators	<ul style="list-style-type: none">a. The test item (and reference item, when used) operating characteristics and limitations.b. The expected test item performance.c. The safety precautions to be observed.d. The kind and extent of all maintenance actions to be taken under all specified environmental conditions.e. All operating procedures to be followed under all environmental and terrain conditions.f. The procedures to be followed when filling out checklists and questionnaires, and their purpose.

TABLE I (Cont'd)

Test evaluators	<ul style="list-style-type: none"> a. The purpose and use of all checklists and questionnaires, and the methods to be used in their evaluation. b. The calculations to be made in evaluating test data.
Topographical analysis support	<ul style="list-style-type: none"> a. Physical terrain features to be measured, including water velocity and terrain slopes. b. Vegetation features to be noted and described.
Maintenance support	<ul style="list-style-type: none"> a. The scheduled maintenance requirements to be met. b. The procedures, equipment and material to be used to make emergency repairs and unscheduled maintenance. c. The kind of recovery vehicle to be used. d. The recovery procedures to be used. e. The maintenance records to be written.
Meteorological support	<ul style="list-style-type: none"> a. The terrain areas which will be used. b. The calendar dates of all tests. c. The readings to be taken.
Soil analyses support	<ul style="list-style-type: none"> a. The nature and location of major terrain soil to be encountered. b. The kind and extent of all soil analyses to be performed.

TABLE I (Cont'd)

General support	<ul style="list-style-type: none"> a. Storage, handling, layout, spacing, pest control, fire protection, security, and inspection procedures to be followed. b. Required organizational maintenance to be performed, including cleaning and microbiological inspection. c. The calendar dates of all inspections.
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6.1.3 User Test

a. The user test will be conducted under simulated field conditions by personnel who would use the equipment in the field. The mission scenario (Appendix A) will describe the test areas and operations that will be used for evaluating the test item.

b. Prepare any additional mission scenarios required to include, as a minimum, the following:

- 1) Details of the test item prime function(s) to be performed in each condition of environment and terrain.
- 2) Sketch map or photomap and description of expected environment to be found in each test course.

6.2 TEST CONDUCT

NOTE: A detailed discussion of humid tropic test conditions is contained in MTP 2-4-003.

6.2.1 Physical and Operating Characteristics

NOTE: The physical and operating characteristics of each test item must be determined prior to conducting environmental tests. This information shall be used as a base for comparison with subsequent data developed in completing the procedures of this MTP for two reasons:

- 1) To avoid attributing performance degradation or malfunctions to tropic testing when the condition was present upon test item receipt.
- 2) To determine precisely performance or structural degradation sustained by the test item as a result of test procedures.

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a. Inspect the packaging and identification markings of items received in conformance with MIL-STD-794 for overseas shipment for level A or B, as applicable.

b. Unpack and remove all preservative coatings on test item(s). Inspect all surfaces for proper painting and other protective coatings. Take color photographs of all surfaces displaying roughness, corrosion or micro-biological growths.

c. Verify completeness of the test item, associated components, and maintenance test package as specified in the Basic Issue Item List (BIIL) and file an Equipment Performance Report (EPR) for any damages or omissions, if required.

d. Determine the physical characteristics of the test item(s) in accordance with the appropriate procedures in the applicable Volume 9 MTP, and MTP 9-3-500. File an EPR for any damages detected.

e. Using the procedures in the applicable draft technical manuals, prepare the test item for normal operation and execute all functions of the test item in all normal modes and ranges of operation.

6.2.2 Operational Performance

a. Using instructions in the draft technical manual, prepare test item for operation in the designated test site.

b. Drive self-propelled item(s), in its travel mode, to test site; use suitable vehicle to transport non-self-propelled item(s) to test site.

c. If test item(s) has not been previously used, perform specified break-in actions.

d. As described in the applicable Volume 9 MTP, perform all functions for which test item was intended to determine if these functions can be successfully completed in the test environment.

e. Continue test operations for a sufficient number of missions to determine the suitability of the test item for continued operation in the test environment. A sufficient number of night missions will be conducted unless safety requires only day missions.

NOTE: Insure that all preventive maintenance, cleaning and lubrication actions prescribed by the draft technical manual for operation in the test environment are followed.

f. Repeat steps a through e for each test site and environmental condition selected for testing.

6.2.3 Short Term Storage

Storage of the test item and/or components shall be consistent with normal practice for the test item commodity class as supplemented by the applicable information in the draft technical manual.

a. Place the test item and/or components in the area designated for short term storage. Unless otherwise specified, minimum use of preservatives should be made.

b. Periodically inspect the test item for evidence of corrosion or microbiological growths. Sample and analyze any growths detected.

c. At completion of the storage period, repeat the procedures of paragraph 6.2.1 steps b, d and e to determine if any deleterious effects have been induced in the test item by storage.

6.2.4 Surveillance

Surveillance testing is performed on items that are subject to rapid deterioration of materials or performance. These items are stored in the humid tropic environment and tested on a continuing basis to determine the extent of deterioration as compared with the original requirements.

a. Prepare the test item for long-term storage as described in the draft technical manual.

b. Store the test item in the specified environment using the applicable procedures described in TM 743-200. Wheeled items shall be blocked so that rubber tires are off the ground. For heavy items, place blocks between the axle and frame to relieve pressure on the springs. Tracked items shall be stored on long dunnage.

c. Conduct surveillance testing in accordance with the applicable guidance supplied in MTP 8-4-004. As described therein, complete periodic inspections will be performed from paragraph 6.2.1 steps b, d and e to determine if any deleterious effects have been induced in the test item by long-term storage. Sample and analyze any microbiological growths detected.

6.2.5 Security from Detection

NOTE: This subtest will be conducted only when specifically requested in the test directive.

a. Position test item in designated test site.

b. Use natural material, nets, tarpaulins, and any other prescribed camouflage material to conceal test item. Place material about site as required to enhance concealment qualities.

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c. Make ground and aerial observations of concealed item at various times of the day and at various distances.

d. Repeat foregoing steps in each test site of interest.

6.2.6 Maintenance Evaluation

When maintenance actions are performed while completing operational performance testing, the following shall be recorded:

a. Scheduled maintenance:

NOTE: For the purpose of testing, scheduled maintenance is to be considered synonymous with preventive maintenance inspections and services.

- 1) If maintenance requirements reflect peculiarities of the course or test activity, provide a description of test course and test activity associated with maintenance performed.
- 2) Procedures and special tools (if any) required to complete maintenance actions.
- 3) Elapsed time since previous scheduled or unscheduled maintenance (whichever is shorter). Identity of previous maintenance performed (scheduled or unscheduled).
- 4) Parts required, if any.
- 5) Elapsed time required to complete maintenance actions.
- 6) Difficulties in completing maintenance actions.

b. Unscheduled maintenance:

- 1) Description of test course, environment and activity under which maintenance requirements developed.
- 2) Procedures and special tools (if any) required to complete maintenance actions.
- 3) Elapsed time since previous scheduled or unscheduled maintenance performed (whichever is shorter). Identity of previous maintenance performed.
- 4) Parts required, if any.
- 5) Elapsed time required to complete maintenance actions.
- 6) Difficulties in completing maintenance actions.

c. Time to complete related maintenance functions.

- 1) Supply delay time.
- 2) Administrative delay time.
- 3) Technical engineering investigations or inspections related to analysis of cause of failure or detection of suspected incipient failures.
- 4) Initial and final technical inspections.

d. For all maintenance performed:

- 1) The adequacy of the draft technical manual.
- 2) The adequacy of the OEM tools and repair parts.
- 3) The adequacy of the safety instructions.

e. Chargeable test item failures.

- NOTES:
1. Consider simultaneous related malfunctions as one failure.
 2. Do not consider as failures those malfunctions which would not affect mission performance.

Malfunctions which the operator/crew cannot remedy by an adjustment, repair or replacement action using the controls, OEM tools and OEM parts within the time established, and which causes, or may cause:

- 1) Failure to commence operation.
- 2) Cessation of operation.
- 3) Degradation of performance capability of the system/subsystem.
- 4) Damage to system/subsystem by continued operation.
- 5) Personnel hazards.
- 6) Test item component (not system) failures which cause accidents.
- 7) Incipient failures corrected by direct or general support maintenance.

f. Non-chargeable test item failures.

- 1) Test item failures which result from not following the prescribed operational and/or maintenance procedures dictated by the applicable technical manual, or which can be directly attributed to improper replacement of components or assemblies.
- 2) Test item failures which result from accidents.
- 3) Incipient failures detected and corrected during scheduled preventive maintenance inspections or services at the organizational level.

NOTE: Normal organizational maintenance performed during the scheduled preventive maintenance service and inspections should be sufficient to give reasonable assurance of trouble-free operation until the next scheduled service. Therefore, no active maintenance, other than operator/crew authorized maintenance, will be performed (if such maintenance effects the system performance) between the scheduled services and inspections unless such maintenance is

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accomplished to correct a chargeable system failure. Examples of permissible maintenance between scheduled services and inspections are--

- a) Replacement of bulbs.
- b) Replacement of fuses.
- c) Replacement of damaged tires.
- d) Tightening of fasteners.
- e) Minor body repair or painting which cannot be deferred.
- f) Normal daily services, including before, after, and during operation checks and services called for in the operator's/maintenance manual.

6.2.7 Safety

a. Do not begin testing until a safety release is received from higher headquarters.

b. Observe the proper safety precautions during testing, and record any conditions that might present a safety hazard, the cause of the hazard, and the steps which were taken to alleviate the hazard.

c. Observe and record all precautions specified in the following documents:

- 1) The test item maintenance test packages.
- 2) USATECOM Regulation 385-6.
- 3) FM 31-30.
- 4) Applicable portions of Appendix B in MTP 2-4-003 (Questionnaires).
- 5) Applicable portions of Appendix C in MTP 2-4-003 (Checklists).
- 6) Applicable portions of specific commodity Volume 9 MTP.

d. Complete the following additional safety evaluations.

- 1) Presence and clarity of safety warnings on test item.
- 2) Adequacy of handling and operating procedures with regard to personnel safety.
- 3) Presence, sufficiency, and adequacy of safety devices.
- 4) Presence of sharp or projecting edges, controls or other hardware.
- 5) Accessibility to emergency cut-off controls.
- 6) Adequacy of emergency equipment and instructions, if applicable.

e. After completing all testing, prepare a safety confirmation for inclusion in the final report if the test item was determined safe for use. If the test item was found to be unsafe, a detailed explanation should be provided.

6.2.8 Human Factors Evaluation

Develop task/item checklists reflecting the human factors design considerations for the test item. These checklists will allow test supervisory personnel to compare test-item features against appropriate criteria and record comments to evaluate the suitability of the man-item interface with particular emphasis on operations under adverse weather conditions. Detailed criteria and human factors considerations for each task may be derived from USAGETA document "Human Factors Evaluation Data for General Equipment (HEDGE) Guidebook Supplement". Consult Appendix C in MTP 2-4-003, MIL-STD-1472, and the following for guidance in preparing a suitable checklist.

a. For all tasks the following factors will be considered:

- 1) Adequacy of instructions and tools to perform the task.
- 2) Mental and physical effort required.
- 3) Design of the test item as it affects the task.
- 4) Time required for the task.
- 5) Personnel required for the task.

b. Perform the following tasks for the HEDGE test functions given. The factors considered shall include, but not be limited to, those of sub-paragraph a above.

1) Operability.

a) Assemble and set-up.

1. Assemble components and make all connections.
2. Make preliminary alignment, calibrate and adjust.

b) Prepare.

1. Check controls, fasteners, connectors.
2. Load expendables (lubricants, fuel, etc.).
3. Close covers, caps, etc.

c) Operate test item.

1. Energize engine; propel carrier.
2. Operate-manipulate controls; perform prime function(s).

2) Maintainability.

a) Perform scheduled maintenance.

1. Clean, add lubricants.

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2. Remove and replace minor items.
 3. Tighten fasteners, connectors.
 4. Adjust, calibrate, align.
 - b) Perform non-scheduled maintenance.
 1. Detection of malfunction by observing displays, noting visual or audible changes, or changes in operating effectiveness.
 2. Isolate and identify causes by visual means or instrumentation.
 - c) Remove and replace.
 1. Open, gain access to and remove component.
 2. Replace or repair and re-establish proper operation.
- 3) Transportability.
 - a) Prepare for transport.
 1. Place in the transit state by removing, collapsing, tightening, locking, and applying protective cover.
 2. Package/containerize, block/brace the test item accessories.
 - b) Load/unload.
 1. Move test item to the carrier; use appropriate MHE and move test item accessories to the carrier.
 2. Place test item and accessories into/onto the carrier.
 - c) Secure/unfasten.
 1. Tie down or secure.
 2. Remove test item from carrier.
 3. Open container, unblock, remove and reinstall test item accessories.

6.2.9 Value Analysis

a. During the conduct of all tests, test personnel shall evaluate the test item from a value versus cost standpoint. Record all pertinent comments concerning features or components which can be eliminated or modified to accomplish cost reduction without impairment of performance, reliability, quality, maintainability, or safety. The applicable portions of USATECOM Regulation 700-1 shall be used for evaluation.

b. Consideration shall be given to the topics listed below. Record appropriate comments.

1) Mission Capacity.

The test item should be capable of accomplishing the specified task with only a reasonable margin of excess capability. Excess capacity and unused capability normally results in unnecessary bulk, excessive weight and unwarranted costs.

2) Simplicity.

Unnecessarily complex components and systems, redundancy, and the use of unneeded parts will increase costs and maintenance efforts.

3) State of the Art.

In many instances the use of recently developed, currently available, components and automated features will result in an overall product improvement and cost savings.

4) Standardization.

The use of identical parts and parts currently in the military system will reduce the overall logistics burden.

5) Materials and Methods of Construction.

Polished surfaces, overdone finishes, and the use of expensive materials will result in unnecessary costs if used inappropriately.

6) Tolerances.

Inadequate tolerances will result in difficulties and delays in accomplishing post arrival assembly, routine maintenance, servicing and repair.

6.3 TEST DATA

a. When measuring attributes, which are subject to small deviations, make at least two, and preferably four, different measurements under identical test conditions, and record each measurement, as well as the arithmetic mean of these measurements.

b. Indicate the accuracy of the measuring device employed.

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c. When progressive degradation is observed on any part, describe and/or photograph the degradation, and show the "before" and "after" condition together when recording.

d. When applicable, show a soil profile of the test course terrain in the test course performance record.

e. When two or more persons are asked to fill out a questionnaire giving their opinion regarding specified features in a particular test, show the scoring values used, and the scoring results obtained, in tabular form as described in Appendix B of MTP 2-4-003 (Questionnaires).

6.3.1 Test Personnel Training and Familiarization

Record the following:

a. For all test personnel:

- 1) MOS and skill level.
- 2) Rank.
- 3) Unit.
- 4) Experience.
- 5) Previous training.

b. Adequacy of draft technical manual for supporting personnel training.

c. Requirements for training aids.

d. Difficulties encountered in completing training program.

6.3.2 Physical and Operating Characteristics

Record the following:

a. Conformance with specified packing, packaging, preserving, identification and marking criteria.

b. Any omissions of components or equipment damage detected.

c. Physical characteristics of the test item as specified in the applicable Volume 9 MTP and MTP 9-3-500.

d. Instances of missing or improper protective coatings on test item. Identify photographs showing roughness, corrosion or microbiological growths.

e. Description of operational condition of test item: provide enough details of tests performed and results obtained to evaluate the operating efficiency of the item in all modes and ranges of operation.

6.3.3 Operational Performance

Record the following for each test site, environment and season (wet or dry) in which testing was conducted.

- a. Data required by applicable Volume 9 MTP detailing the operational performance achieved.
- b. Instances wherein peculiarities of the test site, environment or season impeded test operations or reduced operating efficiency of test item. Provide sufficient details of the test conduct and resulting data to determine accurately what components were affected and the extent to which functions were impaired.
- c. Any deterioration of test item performance or structural condition resulting from environmental testing. Include particulars as to elapsed time, meteorological conditions during test, type of fungus induced, amount of corrosion detected, projected shortened life span of components effected, etc.

6.3.4 Short Term Storage

Record the following:

- a. Condition of the test item(s) just prior to storage, and the storage preparations made, including (if applicable) the shipping containers used.
- b. Storage environment and average meteorological conditions.
- c. Number of items involved, if applicable.
- d. Method and duration of storage of each item.
- e. Results of all inspections made.
- f. Maintenance and repairs made.
- g. Extent of deterioration of operating characteristics.

6.3.5 Surveillance

Record the following:

- a. The condition of the test items immediately prior to storage, and the storage preparations made, including all containers and packaging used.
- b. Storage conditions, environment and average meteorological conditions.

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- c. Number of items involved, if applicable.
- d. Method and duration of storage of each item and the calendar dates of all inspections.
- e. Results of all inspections made.
- f. Maintenance and repairs made
- g. Extent of deterioration.

6.3.6 Security from Detection

Record the following:

- a. Conditions of the terrain in which observations were made.
- b. Implements used to make observations (field glasses, aircraft, etc.).
- c. Distances from which test-item observations were made.
- d. Time of day and sky conditions when observations were made.
- e. Type(s) of material used.
- f. Identity of illustrative photography.

6.3.7 Maintenance Evaluation

Record the following and describe all procedures and special tools used in performing maintenance actions:

- a. Total scheduled maintenance time consumed.
- b. Total unscheduled maintenance time consumed.
- c. Total operating time (in hours).
- d. Total number of scheduled and unscheduled maintenance actions performed.
- e. Total number of chargeable system failures.
- f. Total unscheduled maintenance time expended on chargeable failures (in hours).
- g. Adequacy of the technical manual to support the maintenance program.

- h. Adequacy of the OEM tools and repair parts.
- i. Adequacy of the safety instructions.

6.3.8 Safety

Record the appropriate data as required by the specific Volume 9 MTP for the test item and the following:

- a. A tabulation of all safety features and/or devices.
 - 1) Type of feature/device.
 - 2) Purpose of the feature/device.
 - 3) Suitability of the feature/device.
 - 4) Adequacy of the feature/device.
 - 5) Proper operation of the feature/device.
- b. Adequacy of warning plates, instructions and markings in content, clarity, sufficiency and location.
- c. Any condition that did or might present a safety hazard including cause and corrective action required to alleviate the condition.
- d. Presence and adequacy of fire fighting equipment and suitability of stowage and control location.
- e. Adequacy of ventilating systems to prevent operator exposure to noxious fumes.
- f. Satisfactory/unsatisfactory noise level during period of engine operation.
- g. Suggestions to improve safety features, safety measures and/or precautions.

6.3.9 Human Factors Evaluation

Complete the task/item checklists by rating the inclusion of each design consideration as satisfactory or unsatisfactory.

6.3.10 Value Analysis

- a. Record appropriate comments for each of the topics listed below:

- 1) Mission Capacity.
- 2) Simplicity.
- 3) State of the Art.
- 4) Standardization.
- 5) Materials and Methods of Construction.

6) Tolerances.

b. When making recommendations for changes in test item features or components, record the following:

- 1) The feature or component under consideration.
- 2) Recommended change(s).
- 3) Reason(s) for recommended change(s).

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 General

Summarize all data using tabulations and/or charts as appropriate. Analyze and compare the data collected against specific criteria stated in governing documents. Provide a narrative description of the degree of suitability of the test item for use in the tropics. If the item is not suitable for use in the tropics, provide a complete description (including test results) of why the item is so adjudged.

6.4.2 Questionnaires

When two or more persons are asked to fill out a questionnaire giving their opinion regarding specified features in a particular test, and an analysis of variance is used to test for the significance of the variation in the scoring results, perform this analysis as specified in Appendix B of MTP 2-4-003.

6.4.3 Checklists

Group the answers to all checklist questions under the applicable headings, such as safety, accessibility, and human factors, and arrange the answers in the order of their relative importance.

6.4.4 Maintenance Evaluation

Maintenance observations shall be summarized and presented in narrative form. Data recorded in paragraph 6.3.7 will be tabulated and the following computations will be made:

- a. Mean Time Between Failures (MTBF).

$$\text{MTBF} = \frac{\text{Total operating time (in hours)}}{\text{Total number of chargeable system failures}}$$

- b. Mean Time Between Maintenance (MTBM).

$$\text{MTBM} = \frac{\text{Total operating time (in hours)}}{\text{Total number of scheduled and unscheduled maintenance actions performed}}$$

- c. Mean Active Maintenance Downtime (\bar{M}).

$$\bar{M} = \frac{\text{Total scheduled and unscheduled maintenance time (in hours)}}{\text{Total number of scheduled and unscheduled maintenance actions}}$$

- d. Mean Time to Repair (MTTR).

$$\text{MTTR} = \frac{\text{Total unscheduled maintenance time expended on chargeable failures (in hours)}}{\text{Total number of chargeable system failures}}$$

- e. Inherent Availability (A_i).

$$A_i = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

- f. Achieved Availability (A_a).

$$A_a = \frac{\text{MTBM}}{\text{MTBM} + \bar{M}}$$

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APPENDIX A

Sample Scenario

Location: U. S. Army Tropic Test Center, Fort Clayton, Canal Zone
(79°57'30"W, 9°21'30"N).

Exposure: Evergreen Forest and River.

Simulated Combat Scenario: A Combat Engineer Company is assigned the mission of supporting a river crossing operation for the 1st Brigade of the 8th Infantry Division.

General: a. The jungle provides excellent concealment for river crossing operations in most instances. Troops and hand-carried material can be brought up to almost any desired site without additional road construction. However, when selecting the site, the climatic conditions of the area pertaining to the annual rainfall and flooding conditions must be carefully analyzed. Flash floods are characteristic of most jungle areas, even in the dry season. If heavy equipment is to be used, soil trafficability must be considered.

b. The training and logistical planning must be accomplished to insure that participating personnel are trained and that assault boats, paddles, and other required equipment are on hand in sufficient quantity to support the Crossing Operation. Close coordination with the Tactical Commander is required to insure that all engineer support requirements are met.

Scenario: a. Moving out from the company area engineer crews carry assault equipment to the river crossing site taking advantage of the jungle cover.

b. Infantry elements are organized into assault boat groups and guided to their assigned boat by the responsible engineer boat Commander.

c. Assault boat groups move to the river and begin crossing on order.

d. The boat Commander guides the boat to the predesignated far shore landing site. The other two engineers in the bow of the boat establish the rowing rhythm for the infantry assault crews.

e. Assault boat lands on the far shore, discharges assault troops, and returns to the near shore and prepares to take the second wave of assault troops across the river.

UNCLASSIFIED

Security Classification

MTP 9-4-003

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U.S. Army Test & Evaluation Command Aberdeen Proving Ground, Maryland 21005		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP -----	
3. REPORT TITLE U.S. Army Test and Evaluation Command Materiel Test Procedure Common Tropic Environmental Test Procedure "Construction, Support & Service Equipment"			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Final			
5. AUTHOR(S) (First name, middle initial, last name) -----			
6. REPORT DATE 13 January 1971		7a. TOTAL NO. OF PAGES 24	7b. NO. OF REFS 18
8a. CONTRACT OR GRANT NO. b. PROJECT NO. AMCR 310-6 c. d.		9a. ORIGINATOR'S REPORT NUMBER(S) MTP 9-4-003 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
10. DISTRIBUTION STATEMENT Distribution of this document is unlimited			
11. SUPPLEMENTARY NOTES -----		12. SPONSORING MILITARY ACTIVITY Headquarters U.S. Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005	
13. ABSTRACT Basic procedures concerning the evaluation of construction, support and service equipment in the tropic environment are described.			

DD FORM 1473

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

A-1

UNCLASSIFIED

Security Classification

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Security Classification

14	KEY WORDS	LINK A		LINK B		LINK C	
		ROLE	WT	ROLE	WT	ROLE	WT
Tropic storage Tropic surveillance							